THE BOOK OF WILLIAM BEAUMONT AFTER ONE HUNDRED YEARS*

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We have met together this evening to commemorate, not the birth or death of a great man, but the hundredth anniversary of the publication of a book. That book, which appeared in the fall of 1833, had no preparatory acclaim, it was not featured in extensive advertising, it was a modest octavo volume, printed in a newspaper office in the small town of Plattsburgh, bound in pasteboard, and sold by subscription. Certainly this was not a promising start. And yet, five years later the book was reprinted in an English edition, nine years later still (in 1847) a second American edition was brought out, and meanwhile, in 1834, a German translation had been published in Leipzig. In 1929, when the thirteenth International Congress of Physiology was held in Boston, the Federation of American Societies of Experimental Biology, which on that occasion acted as hosts to visiting physiologists, biochemists and pharmacologists from all parts of the world, memorialized Dr. Beaumont in a medal and presented to the members of the Congress a facsimile reproduction of Beaumont's famous volume.**

In the period between 1833 and 1933 thousands of other books have been written and published, have had their brief day and ceased to be. What was there in Beaumont's writing that endowed it with vitality and permanent value? It possessed those qualities because it embodied the simple, straightforward report of a scrupulously honest man who used his senses cautiously in a significant scientific enquiry, who recorded exactly how he used them and what they re-

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**It is worthy of note that Dr. John F. Fulton, Professor of Physiology in the Yale School of Medicine, permitted his copy of the first edition of Beaumont's classic to be cut apart for the zincograph process involved in the exact reproduction of the original pages.

vealed, and who drew limited inferences from the observed facts. He had, to be sure, an unusual condition to study and describe—a human being with a direct opening into the stomach on the left side of the body, through which instruments and food could be introduced and through which also the gastric contents and the digestive juice could be extracted. The willful, bibulous, and at times probably patient, Alexis St. Martin was not, however, the first person who had a gastric fistula. Myer[1], in his biography of Beaumont, cites an impressive number of such cases which had been noted in medical literature before 1830. In none of them had there been a man at hand who had the interest, the sense of value and the persistence that William Beaumont manifested during the years of his investigation.

The conditions which surrounded him were in many respects highly unfavorable both to the prosecution of research and to the securing of satisfactory results. It was at a frontier army post on the Island of Machilimacinac, near the union of Lake Michigan and Lake Huron, that the young Canadian hunter, Alexis St. Martin, received the gun shot which fractured ribs and made openings into the cavities of the chest and abdomen. Portions of the lungs and stomach, much lacerated and burnt, protruded through the openings, making, according to the record, "an appalling and hopeless case." The life of the wounded man was despaired of, but, by careful attention and treatment, and, no doubt in part because of his own youthful vigor, he recovered, in about ten months, sufficiently to promise ultimate survival. Even at that time, however, he was "altogether miserable and helpless," and since no one else would look after his needs, Beaumont took him into his own home and "medically and surgically treated and sustained him, at much inconvenience and expense, for nearly two years, dressing his wounds daily, and for a considerable part of the time twice a day, nursed him, fed him, clothed him, lodged him and furnished him with such necessities and comforts as his conditions and sufferings required" (1, p. 213).

The opportunity for making the "experiments and observations" was obviously not one that was presented ready for use but was the consequence of persistent and exacting professional skill and of humane consideration for a desperately injured man. Toward the end of the long and tedious convalescence the unique chance of studying "the gastric fluids and the process of digestion" in a normal human being became apparent. And in August, 1825, Beaumont made a few tentative observations (he records only four) on gastric temperature and the changes in beef and chicken as they occurred in the stomach and in glass vials containing extracted gastric juice. He was not able to continue these observations, however, because St. Martin, ungrateful to the physician who had saved his life, took what may be called "Canadian French leave," and returned to his home near Montreal. There he married and though employed by the Hudson Bay Company managed to support his wife and children only in miserable poverty. Meanwhile Beaumont had urged friends in the American Fur Company to be on the lookout for the missing man and had spent sums from his own meagre income as an army surgeon to obtain trace of him. After St. Martin's whereabouts were discovered, in 1827, two more years passed before he was persuaded, with "considerable difficulty and at great expense to his benefactor" to make the journey of nearly two thousand miles with his family from their Canadian home to Fort Crawford, on the Mississippi River, in Michigan Territory, the city where Prairie du Chien*, Wisconsin, now stands and where Beaumont was then stationed.

Old Fort Crawford was built on the flood plain of the Mississippi just above the point where the Wisconsin River contributes its waters—a flat stretch of land below the limestone bluffs, that had long been a natural center of

*"Chien" pronounced "sheen." When the troops left the settlement in 1856 the local newspaper printed the lines:

"The like o' them may never be seen
By boys or men in Prairie du Chien."

intercourse and barter for the Indian tribes of the region and which became naturally a convenient meeting place for Indians and traders at a later day. The place witnessed in a typical fashion all stages of the advance of the American frontier. As Mahan[2] has written, in his entertaining story of the Fort, Prairie du Chien "was a focal point in an area where a colorful pageant of the Middle West unfolded —the coming of the French, the supremacy of the English, ... the establishment of military posts by the United States, and the founding of American communities. Indians, French explorers, missionaries, traders, trappers, *voyageurs* and *coureurs des bois,* Englishmen, Spaniards, Americans, miners, frontier soldiers and settlers were the characters in this struggle of nations for the wealth of the Upper Mississippi Valley—fur and lead and homes." In 1825, hundreds of representatives of the various Indian tribes, all arrayed in their picturesque devices of decorative feathers, quills and horse hair, and carrying their painted war clubs and drums, met on the Prairie in what has been called one of the most imposing councils ever held between the whites and the red men. Here was the very edge of our civilization. To this straggling frontier village, with its nondescript population of Indians, Frenchmen, half-breeds, and a few American settlers, Dr. Beaumont brought his family in 1826. There Alexis St. Martin came three years later, and there he and his family remained in Beaumont's employ from August, 1829 to March, 1831—a period marked by turbulence and anxiety because of the restlessness of the hostile Indian tribes.

I have described the conditions at Prairie du Chien and at Old Fort Crawford in order that the unpropitious background of circumstance in which Beaumont carried on his physiological studies may be understood. In an environment where the very words "scholarship" and "research" would not be comprehended, with none of the opportunities for conference and sympathetic discussion with fellow-workers that we call "atmosphere," indeed, with no scientific companions; with no library, no journals, no possibilities of consulting experts in any difficulty; and with no

laboratory equipment except a thermometer, a few vials, and a sand bath, he carried on a series of observations on the gastric juice and the gastric digestive process which during the hundred years that have elapsed since then have not failed to call forth the admiration of all who have read his record. He was a frontiersman in a new realm of intellectual interest, while surrounded by the most grim and forbidding environment of a frontier of civilization. And because, as he wrote, he conducted his investigations in "the true spirit of enquiry," without any "particular hypothesis to support," and because he "honestly recorded the result of each experiment exactly as it occurred," his observations have been a permanent monument to his devoted labor.

During the winter of 1832-33 Beaumont was given a six-months' furlough which he spent in Washington. There he had opportunity to consult the writings of other men who had studied and thought about the functions of the stomach—an opportunity which he used in part to make an elaborate and detailed summary of previous literature, with comments based on his own experience. There also he conducted a third series of experiments on St. Martin. After a period of service in this city of New York during the spring of 1833, he was, in July, transferred to Plattsburgh, where he made more observations (a fourth series). Although the third and fourth series were carried on under more favorable circumstances than those prevailing at the frontier army post in the wilds of Michigan territory, the methods employed were those which he developed there and the results obtained were in large degree confirmatory of the earlier results. It was at Old Fort Crawford, surrounded by savages and rough pioneers, that Beaumont laid the foundation for both of his later studies.

In the quiet of Plattsburgh during the summer of 1833, the book, "Experiments and Observations on the Gastric Juice and the Physiology of Digestion," was prepared for publication. Beaumont confessed that he found it "an immense job"—like many another investigator when he

has come to the task of describing what he has done and what he has discovered. In the autumn of that year, almost exactly a century ago, the first copies of the volume appeared and began to be distributed.

I have suggested earlier that the reason for the permanent value of Beaumont's book lies in the straightforward recording of observed facts. That aspect of his contribution to medical science he himself emphasized. And that aspect was stressed also by Sir Andrew Combe, the Edinburgh physiologist, who sponsored the English edition of the book, which was published in 1838.

"Among the disciplined physiologists of Europe," Combe wrote, "a more systematic experimenter might certainly have been found, but in Dr. Beaumont's instance the absence of systematized inquiry—made too generally in support of preconceived theory, and therefore apt to mislead as well as instruct—is more than compensated by the implicit reliance which one feels can be placed on the accuracy and candor of his statements. Having no theory to support, and no favorite point to establish, Dr. Beaumont tells plainly what he saw, and leaves everyone to draw his own inferences; or, where he lays down conclusions, he does so with a degree of modesty and fairness of which few persons in his circumstances would have been capable."

This judgment, though discriminating, does not, I think, sufficiently stress Beaumont's boldness and independence when he was convinced of the correctness of his facts and the reasonableness of the inferences to be drawn from them. Consider, for example, his discussions of thirst. In 1833, Magendie was one of the foremost physiologists of the world. He had written that "thirst is an internal sensation, and instinctive sentiment," "the result of organization, and does not admit of any explanation." Beaumont, "a mere tyro in science," "a simple experimenter," as he modestly called himself, utterly rejected the limitation which the renowned physiologist had laid down. "Thirst is no more an instinctive sentiment," he declared, "than any other sensation of the economy; to say it is the result of organization gives no explanation, amounts to nothing, and is certainly, to say the least, a very unsatisfactory way of disposing of the question" (3, p. 61). And in the face of the edict that

thirst is inexplicable, Beaumont suggested that it is a sensation arising from the mouth and fauces, a feeling of dryness due to evaporation of moisture from the surfaces of those regions, because the respired air passing to and fro over them takes up the moisture faster than it can be supplied. In attributing thirst to a local source at the back of the buccal cavity the backwoods physiologist was, according to modern evidence, on sounder ground than Magendie's successor, the eminent French savant, Claude Bernard, who regarded it as a "general sensation."

And consider Beaumont's comments on the nature of hunger—another example of his clear thinking and self-reliance. With reference to the statement that hunger is produced by action of the nervous system and has no other seat than that system, he affirmed, "I cannot perceive that such explanations bring the mind to any satisfactory understanding of the subject. In such a broad proposition it is difficult to ascertain the exact meaning. If the design is to convey the impression that hunger has no 'local habitation'; that it is an impression affecting all the nerves of the system in the same manner, then the sensation would be as likely to be referred to one organ as another." Furthermore, he argued against certain explanations of the local gastric source of the hunger pang. It is not due to the friction of the internal coats of the stomach for three different reasons which he advanced; nor due to irritation of a quantity of gastric juice in the stomach for it is not there; nor to the "energetic state of the gastric nerves" as had been suggested, for that is unexplored territory; nor to the "foresight of the vital principle," a phrase which, at a time when Johannes Müller was supporting vitalism, Beaumont declared "means anything, everything or nothing, according to the construction which each one may put upon it" (3, p. 55). These frank, incisive comments give relish even as one reads them today. "Such explanations," in his opinion, "conduce nothing to the promotion of science. They are mere sounds and words, which ingeniously convey a tacit acknowledgment of the author's

ignorance." Beaumont reasoned that the sensation of hunger must have its source in the stomach itself—a view which is supported by modern evidence. And he carefully recorded (3, p. 208) that when food was introduced through St. Martin's fistula the sensation of hunger immediately disappeared and therewith "stopped the borborygmus, or croaking noise, caused by the motion of air in the stomach and intestines, peculiar to him since the wound, and almost always observed when the stomach is empty." The result of this experiment was cited to indicate that the sensation of hunger originates in the stomach, but the further inference was not drawn that the "croaking noise" could only be due to a vibration of air forced by muscular pressure through a narrow orifice. If that step had been taken, the present explanation of hunger as a result of strong contractions or spasm of the gastric musculature would have long been anticipated.

Equipped, then, with a true appreciation of the opportunity which chance had offered him, with enthusiastic persistence in his quest, with shrewd and critical powers of observation, with sincere purpose to record accurately what his experiments revealed, with a high degree of independence and self-reliance in his judgment—and with little else—Beaumont pursued his studies, when his duties as army surgeon did not interfere, during the years 1829-1833. At the end of his book he listed fifty-one "inferences" from his tests and experiments. A few of these inferences have been superseded because they were not in accord with results obtained later under more favorable conditions; some of the inferences anticipated in a remarkable manner facts proved by quite modern investigations; and many of them have been confirmed and incorporated in the general body of physiological and clinical knowledge. It will not be possible here to consider in detail all these aspects of Beaumont's contributions. We must restrict our attention to relatively few of them, and in doing so it would be well for us to keep in mind the words of Meek[4]:

"One must remember the scientific condition of his times. . . . When Beaumont was working at Old Fort Crawford there was no such science as organized physiology. Ludwig, Helmholtz and Bernard, the great masters of this medical field, were boys of five, ten and eighteen years. Hoppe-Seiler was five years old, and Kühne and Emil Fischer were yet unborn. Beaumont never heard such terms as 'protein,' 'enzyme,' 'calories' or 'vitamines'."

Problems of importance at the time centered on the nature of gastric juice. There was still discussion concerning its acidity and its action as digestive agent. Beaumont took part in settling these questions. In 1824, Prout had shown that during digestion the juice contains hydrochloric acid—a discovery made independently by Tiedeman and Gmelin and reported in 1826. Beaumont's observations in 1825 proved that the human juice is a very active solvent; and in the samples which he submitted to Dunglison and Silliman for analysis an amount of hydrochloric acid was found which was surprisingly large. The description of gastric juice which Beaumont presented in his book is an excellent example of simple, clear statement:

"Pure gastric juice," he wrote, "when taken out of the stomach of a healthy adult, unmixed with any other fluid, save a portion of the mucus of the stomach with which it is most commonly and perhaps always combined, is a clear, transparent fluid; inodorous; a little saltish, and very perceptibly acid. Its taste, when applied to the tongue, is similar to thin mucilaginous water, slightly acidulated with muriatic acid. It is readily diffusible in water, wine or spirits; slightly effervesces with alkalis; and is an effectual solvent of the *materia alimentaria.* It possesses the property of coagulating albumen, in an eminent degree; is powerfully antiseptic, checking the putrefaction of meat; and effectually restorative of healthy action, when applied to old, foetid sores, and foul, ulcerating surfaces" (3, p. 84).

That is a fairly detailed account of the properties and functions of the gastric secretion. It is interesting to note that Beaumont took care to test comparatively the action of a measured amount of dilute hydrochloric acid by itself and a measured amount of the juice on the same quantity of boiled beef, and, finding that the juice completely dissolved the beef while the acid only turned it to "a jelly-like consistency," he drew the prudent conclusion that "probably the gastric juice contains some principles inappreciable to the senses or to chemical tests." In 1835, Schwann

proved the correctness of Beaumont's keen insight by demonstrating the presence of one of these "principles," the enzyme, pepsin. Rennin is perhaps another. And now the latest studies on pernicious anemia indicate yet another "principle" in the gastric juice, the nature of which is still obscure.

Although Beaumont did not note the nice relation between the mastication of sapid food and the flow from the stomach wall, which we recognize as "psychic secretion," he found that when "alimentary matter" is received in the stomach the juice exudes from its "proper vessels" and "increases in proportion to the quantity of aliment" (3, p. 85)—an observation quite in accord with the much later, more exactly quantitative studies of Pavlov.

No such elaborate examination of the temperature of the viscera has been undertaken by any other investigator as that conducted by Beaumont (cf. 3, p. 273). He read the thermometer introduced into the stomach during repose and after exercise, while the organ was empty and while digesting, when healthy and when inflamed, on days cold and days warm, and in all sorts of weather. It was his only fairly exact instrument and he used it fully. Exercise elevated the temperature, he found, an observation abundantly confirmed by more recent studies. And he was led to compare the effects of temperature on digestion *in ventriculo* and *in vitro,* when he noted that only if the gastric juice was kept warm did the process of chymification go on in a satisfactory manner. When the cold juice was warmed, however, "digestion commenced, and advanced regularly" (3, p. 152). He suggested that the accelerating influence of gentle exercise on gastric digestion might be due to the increase in temperature, for gastric juice "like other chemical solvents," he wrote, would have the rapidity of its action "increased in proportion to the elevation of temperature" (3, p. 94).

By comparing the course of digestion of food introduced in fine division and in coarse lumps into the stomach, and by similar experiments in glass vials, Beaumont was led to

lay emphasis on the importance of mastication, which he regarded as "absolutely necessary to healthy digestion." If meat in a large mass was passed through the fistula it underwent digestive changes much more slowly than if minutely divided. The quantity of the food likewise affected the speed of the digestive process. Although Beaumont made extensive and repeated observations on the time required for chymification of various foods (cf. 3, pp. 41-45, 269-272), and from these data drew the general conclusion that "*animal* and *farinaceous* aliments are more easy of digestion than *vegetable*," and although his tables of digestibility of different articles of diet have been generally regarded as an important contribution to practical dietetics, the absence of reference to the state of comminution of the foods, and especially the failure to state the amounts ingested, must be regarded as seriously affecting the reliability of the figures.

In connection with the study of the treatment of different food-stuffs in the stomach, there were incidental observations of some interest. One was the surmise that "the ultimate principles of nutriment are probably always the same, whether obtained from animal or vegetable diet" (3, p. 36). As Meek[4] has pointed out, it was not until the time of Emil Fischer that these words of Beaumont were proved to be significant and indicative of a prophetic shrewdness of reasoning. Another incidental fact noted by Beaumont was that fat or oily foods, "though containing a large proportion of the nutrient principles," are difficult of digestion, i.e., they remain long in the stomach. This observation is quite in accord with results of recent studies which have shown that fats retard the secretion of gastric juice, diminish the intensity and speed of peristalsis, and cause reflux of bile into the stomach—a phenomenon seen to occur in Alexis St. Martin (5, p. 115). Quite unlike "oily substances" are "*water, ardent spirits* and most other *fluids*"; they "are not affected by gastric juice, but pass from the stomach soon after they have been received" (3, p. 97). This observation, likewise, has received support in

relatively recent work. Cohnheim[6], in 1907, called attention to the rapid discharge of water through the pylorus, and assumed that it passes by way of the "Magenstrasse," a channel along the lesser curvature, directly from the cardia to the pyloric opening. All these confirmations of Beaumont's reports testify strongly to his skill and insight as an observer and to his exactness as a recorder.

With consideration of the handicaps under which he labored his description of the motions of the stomach is quite remarkable. He was able to identify "particular portions of the food" as he looked through the fistula, and by noting their movements and also the movements of a thermometer pushed various depths into the gastric cavity, and finding occasional resistance to its withdrawal, he came to the conclusion (3, p. 115) that

"the circular or transverse muscles contract progressively, from left to right [he speaks elsewhere of *peristaltic* motion]. When the impulse arrives at the *transverse band,* this is excited to a more forcible contraction, and, closing upon the alimentary matter and fluids, contained in the pyloric end, prevents their regurgitation. The muscles of the pyloric end, now contracting upon the contents detained there, separate and expel some portion of the chyme."

This is a quite exact account of the type of peristalsis seen in the human stomach, when the peristaltic wave is followed by systole of the antrum—an account all the more remarkable because so largely inferred from the behavior of the projecting end of a glass rod! The inference that the peristaltic wave normally reverses and that there is a circulation of the gastric content along the walls was not so happy, for X-ray examination of the stomach does not support it.

There remains to be considered Beaumont's testimony regarding certain conditions which may influence the digestive process. He noted that "severe and fatiguing exercise retards digestion" (3, p. 94). In 1911, Mantelli[7] likewise observed that exhausting labor is associated with failure of proper action of the gastro-intestinal tract—for an hour or two after strenuous muscular exertion the stomach does not respond normally to the presence of food. Again, Beaumont noted in St. Martin the participation of

the stomach in a general bodily disorder. Occasionally there was an abnormal appearance of the gastric mucosa accompanied by dryness of the mouth, thirst, exaggerated pulse, etc. Under these circumstances, he states, "no gastric juice can be extracted, not even on the application of alimentary stimulus . . . food taken in this condition of the stomach remains undigested for 24 or 48 hours, or more, increasing the derangement of the whole alimentary canal, and aggravating the general symptoms of the disease" (3, p. 108). Similar observations by recent investigators has paid tribute to Beaumont's sure vision. Alvarez[8] has cited autopsies on patients who have died of botulism, in whose stomach has been found food eaten many days before, when the trouble commenced. And similar stagnation of the gastric contents is often noticed in men and women suffering from tuberculosis and other infectious diseases.

Finally may be mentioned Beaumont's testimony to the profound influence of emotional disturbances on the secretion of gastric juice and on digestion. He had more than one occasion to see the phenomenon in St. Martin. Violent passion, he declared, is likely to cause a reflux of bile into the stomach, a change in the properties of the chyme, and a retardation or other disturbances of the chyme in its passage onward into the intestines (3, pp. 153-154). Fear and anger, he noted, check the secretion of gastric juice (3, p. 87). These relations between strong emotions and the inhibition of both gastric secretion and gastric discharge are fundamental not only for the physiology of the digestive canal but also for the clinical understanding of digestive disorders.

Such, then, are some of the more outstanding results of Beaumont's four years of research on St. Martin. There were, however, important indirect results. In 1843, a French investigator, Blondot, took the hint offered by the accident to the Canadian hunter, and began an experimental study of digestion by making an artificial gastric fistula in animals. At about the same time, and, it seems, quite

independently, Bassov, a Russian, did likewise. A few years later Claude Bernard also made use of the method for a variety of purposes. In 1876, toward the end of his career, Bernard[9] testified that Beaumont's researches had opened a new epoch in the history of our knowledge of the digestive processes. This judgment had been formed, however, much earlier, as proved by the following letter from W. G. Edwards, an American student in the Paris laboratory, who, in 1850, wrote to Beaumont in these words:

"The publication of your observation, exposing so clearly and analytically the physiology of the stomach, was the commencement of a new era in the study of this important organ and those associated with it. Your experiments are constantly imitated here upon animals, by a large number of investigating physiologists, among whom M. Bernard probably stands first. His discoveries . . . have rendered the functions of the pancreas, liver, etc., as clear as yours did those of the stomach, but his observations have necessarily been limited to animals, and in the absence of yours upon man would lose much of their value, since no other evidence exists of the identity of the process of digestion in man and the lower animals" (1, p. 289).

The use of the fistula method for examining the digestive functions reached its climax in the renowned researches of Pavlov and his school at Leningrad, that gave to Pavlov the Nobel prize. In his well-known treatise, "The Work of the Digestive Glands," Pavlov recognized the path-finding contribution of the pioneer American physiologist.

In closing may I be permitted to make a few general comments on Beaumont and his services to medical knowledge.

It is a phenomenon of arresting importance that some of the most valuable additions to science have been made by members of army medical corps. So long as he was engaged in research Beaumont belonged to that division of the United States Army. It was another member of the Corps, A. J. Myer, who "during his leisure hours at his isolated post" in New Mexico, devoted himself to devising a simple method of visual communication, which developed into the wig-wag system and the modern Signal Corps of the Army. Still another army medical officer, Walter Reed, carried on the investigations which have freed vast areas from the dread scourge of yellow fever. I need only men-

tion Ronald Ross, David Bruce, William Leishman and Laveran, to bring to your minds the striking fact that physicians in army service have made some of the most significant contributions to medical progress. How shall we account for this fact? Although the circumstances may never have been so unfavorable as they were at Old Fort Crawford, rarely have they included handy and well-equipped laboratories, libraries and stimulating atmosphere. Is it not possible that the essential condition that was provided was leisure—freedom from social and professional demands, from boards and councils, from commissions and committee meetings, from all manner of distracting obligations? You may outfit an investigator in a dusty garret or a dark cellar, you may pay him so little that he must live on simple fare and clothe himself in frayed garments, but if you provide him *time* he can advance his work. Take away time but give him all else in a manner *de luxe,* and he is useless. Necessity may be the mother of invention, Michael Foster once remarked, but "leisure is the mother of discovery." That leisure was the essential condition for Beaumont's success is indicated by a letter which he wrote April 16, 1833, after six weeks in New York City.

"I have been unable to do much at accurate experiments and observations since I came here, so numerous and increasing are the calls of the curious, the social, the scientific and the professional . . . I am determined to do it [i.e., complete a series of studies] soon, however, if I even have to shut myself up with Alexis in a convent, or retire to some seclusion in the country. My official duties are very light, and would not interfere at all with my experiments, could I avoid the vexatious social intercourse to which I am perpetually exposed in this City. It is an unfavorable place for the pursuit of physiological inquiries and experiments" (1, p. 168).

No doubt the charge brought against the City of New York in 1833 could quite as justly have been brought against other large cities at that time. Laboratories have since provided the "seclusion" which Beaumont sought, but even their isolation may be endangered. It is time, free time, that must be assured, a proviso which Beaumont pathetically lost in the years of his active practice in St. Louis after leaving the Army.

Earlier in this address I referred to Beaumont, conducting his researches at Prairie du Chien, as being a frontiersman in two senses—in the dim region that lies between the known and the unknown, and in that advancing fringe of civilization whose movement westward has been one of the most romantic and stimulating aspects of our country's history. Observers of events have called attention to the disappearance of our geographical frontier. The boldness, resourcefulness, imagination, the hardihood and self-reliance, which pioneer life and its sudden hazards demanded, are said to be no longer requisite. And we are advised that we must settle down to the hum-drum of organizing our ways in rigid positions. Is not that prospect outlook, however, too superficial and too bleak? In one of his essays Samuel Crothers once remarked that there was no fixed line between the East and the West—it lay where the look changed from day-before-yesterday to day-after-tomorrow. In our laboratories the forward look of American pioneers is still possible and will continue to be possible for indefinite time to come. The frontier of knowledge is pushed forward with painful slowness, and always as new advance is achieved, new territory to be explored is freshly revealed. One can enter a laboratory, set to work, and in a short time see things quite as unexpected and thrilling, and perhaps more significant, than anything to be found by traveling to the earth's frigid poles. We may feel grateful that the attractions and excitements and rewards of pioneering are still provided in the realm of scientific research, and that the admirable virtues of the frontiersman are still serviceable in securing the advancement of knowledge.

Every community in the western sweep of American civilization had as a part of its history that heroic period when log cabins or sod huts, dangers from hostile savages, and hardships and privations, had to be endured. In the main the memories of those days of peril and hardihood have faded away. They have been displaced by the obvious development of cultivated farms, of organized cities, and

the establishment of schools and universities, made possible because of victory in the harsh struggle against the wilderness. Old Fort Crawford has disappeared, until no trace remains. The part it played in the westward migration of our people has been largely forgotten. But, as we have seen, the Fort served for a few years as a place where pioneering in science was carried on. That sort of pioneering is almost certain to make a persistent impression. Its results must be recorded in printed words. The words are lasting, and perhaps long afterwards the facts which they proclaim fit in with the facts obtained by others. Thus the firm structure of scientific truth is built. Though the Old Fort on the Upper Mississippi has vanished, the results of the experiments which Beaumont conducted within its walls have come down to us with undiminished lustre through these hundred years and are an enduring portion of America's gift to knowledge. "Truth, like beauty," Beaumont wrote, "when 'unadorned is adorned the most,' and in prosecuting these experiments and enquiries I believe I have been guided by its light." Such are the ideals of every frontiersman in science, and insofar as he lives up to them he leaves behind him, as Beaumont did in his book, permanent contributions from his fleeting years.

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